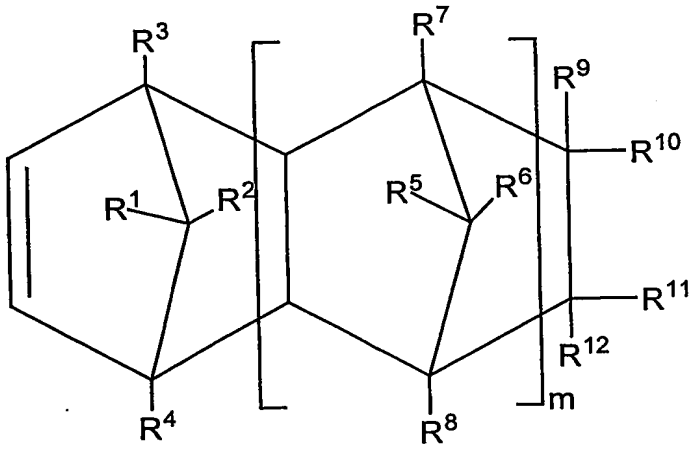
CLAIMS

What is claimed is:

1. A fluorine-containing copolymer comprising:
   a) a repeat unit derived from an ethylenically unsaturated compound having at least one fluorine atom covalently attached to an ethylenically unsaturated carbon atom; and
   b) a repeat unit derived from an ethylenically unsaturated cyclic compound of structure:



wherein m is 0, 1 or 2;

R^1 to R^{12} are independently H, halogen, carboxyl, OH, or O_2C-R^{13}, wherein R^{13} is a C_1-C_{20} hydrocarbon group and at least one of R^1 to R^{12} is OH or O_2C-R^{13}.

2. The fluorine-containing copolymer of Claim 1, wherein R^1 to R^{11} are each hydrogen, m is zero, and R^{12} is OH or O_2C-R^{13}, wherein R^{13} is a C_1-C_{20} hydrocarbon group.

3. The fluorine-containing copolymer of Claim 2, wherein R^{13} is a linear or branched alkyl group of 1 to 10 carbon atoms.

4. The fluorine-containing copolymer of Claim 3, wherein R^{13} is methyl, ethyl or propyl.

5. The fluorine containing copolymer of Claim 1, wherein the halogen is chlorine, fluorine, or bromine.

6. The fluorine-containing copolymer of Claim 1, wherein repeat unit (a) is derived from tetrafluoroethylene, hexafluoropropylene, chlorotrifluoroethylene, trifluoroethylene, vinyl fluoride, vinylidene fluoride,

perfluoro-(2,2-dimethyl-1,3-dioxole), perfluoro-(2-methylene-4-methyl-1,3-dioxolane), $CF_2=CFO(CF_2)_tCF=CF_2$, wherein t is 1 or 2, or $R_fOCF=CF_2$ wherein R_f is a saturated fluoroalkyl group of from 1 to 10 carbon atoms.

7. The fluorine-containing copolymer of Claim 6, wherein repeat unit (a) is derived from tetrafluoroethylene.

8. The fluorine-containing copolymer of Claim 1, further comprising a repeat unit derived from tert-butyl acrylate or methyl adamantyl acrylate.

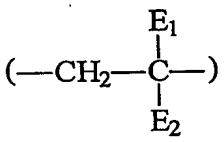
9. The fluorine-containing copolymer of Claim 1, further comprising a repeat unit which is a norbornyl fluoroalcohol or a protected norbornyl fluoroalcohol.

10. The fluorine-containing copolymer of Claim 1, further comprising a fluoroalcohol group derived from an ethylenically unsaturated compound containing a fluoroalcohol group having the structure:

$$-C(R_f)(R_f')OH$$

wherein R_f and R_f' are the same or different fluoroalkyl groups of from 1 to 10 carbon atoms or taken together are $(CF_2)_n$ wherein n is 2 to 10.

11. The fluorine containing copolymer of Claim 1, further comprising an acid-containing or protected acid-containing structural unit:



wherein E_1 is H or C_1-C_{12} alkyl; E_2 is CO_2E_3, or SO_3E; and E and E_3 are H or unsubstituted or heteroatom-substituted C_1-C_{12} alkyl.

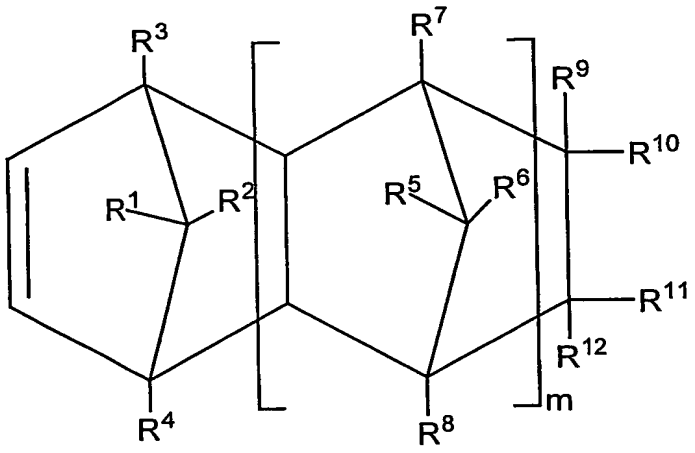
12. The fluorine containing copolymer of Claim 11, wherein the heteroatom is S, O, or N.

13. A photoresist composition comprising:

(a) a fluorine-containing copolymer comprising:

(i) a repeat unit derived from an ethylenically unsaturated compound having at least one fluorine atom covalently attached to an ethylenically unsaturated carbon atom; and

(ii) a repeat unit derived from an ethylenically unsaturated cyclic compound of structure:



wherein m is 0, 1 or 2;

R^1 to R^{12} are independently H, halogen, carboxyl, OH, or O_2C-R^{13}, wherein R^{13} is a C_1-C_{20} hydrocarbon group and at least one of R^1 to R^{12} is OH or O_2C-R^{13}; and

(b) a photoactive component.

14. The photoresist composition of Claim 13, wherein R^1 to R^{11} are each hydrogen, m is zero, and R^{12} is OH or O_2C-R^{13} wherein R^{13} is a C_1-C_{20} hydrocarbon group.

15. The photoresist composition of Claim 14, wherein R^{13} is a linear or branched alkyl group of 1 to 10 carbon atoms.

16. The photoresist composition of Claim 15, wherein R^{13} is methyl, ethyl or propyl.

17. The photoresist composition of Claim 13, wherein the halogen is chlorine, fluorine, or bromine.

18. The photoresist composition of Claim 13, wherein repeat unit (i) is derived from tetrafluoroethylene, hexafluoropropylene, chlorotrifluoroethylene, trifluoroethylene, vinyl fluoride, vinylidene fluoride, perfluoro-(2,2-dimethyl-1,3-dioxole), perfluoro-(2-methylene-4-methyl-1,3-dioxolane), CF_2=$CFO(CF_2)_tCF$=CF_2, wherein t is 1 or 2, or R_fOCF=CF_2 wherein R_f is a saturated fluoroalkyl group of from 1 to 10 carbon atoms.

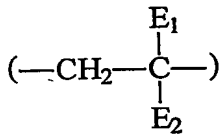
19. The photoresist composition of Claim 13, wherein the fluorine containing copolymer further comprises a fluoroalcohol group derived from

an ethylenically unsaturated compound containing a fluoroalcohol group having the structure:

$$-C(R_f)(R_f')OH$$

wherein R_f and R_f' are the same or different fluoroalkyl groups of from 1 to 10 carbon atoms or taken together are $(CF_2)_n$ wherein n is 2 to 10.

20. The photoresist composition of Claim 13, wherein the fluorine-containing copolymer further comprises an acid-containing or protected acid-containing structural unit:



wherein E_1 is H or C_1-C_{12} alkyl; E_2 is CO_2E_3, or SO_3E; and E and E_3 are H or unsubstituted or heteroatom-substituted C_1-C_{12} alkyl.

21. The photoresist composition of Claim 20, wherein the heteroatom is S, O, or N.

22. The photoresist composition of Claim 13, wherein the photoactive component is a photoacid generator.

23. The photoresist composition of Claim 13, further comprising a dissolution inhibitor.

24. The photoresist composition of Claim 13, further comprising a solvent.

25. A coated substrate comprising:

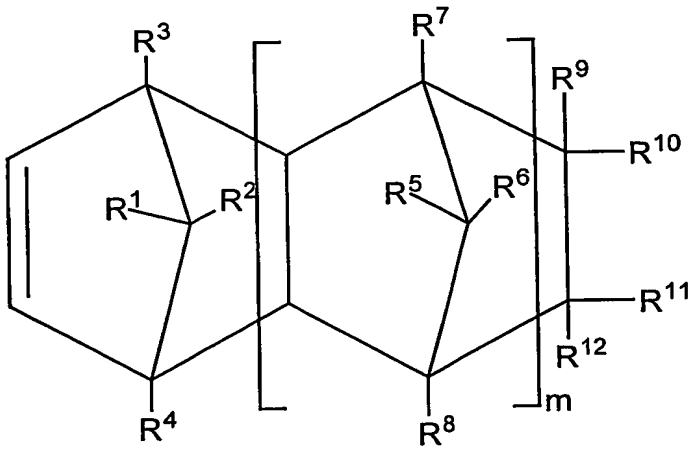
(a) a substrate; and

(b) a photoresist composition comprising:

(i) a fluorine-containing copolymer comprising:

(a') a repeat unit derived from an ethylenically unsaturated compound having at least one fluorine atom covalently attached to an ethylenically unsaturated carbon atom; and

(b') a repeat unit derived from an ethylenically unsaturated cyclic compound of structure:



wherein m is 0, 1 or 2;

R^1 to R^{12} are independently H, halogen, carboxyl, OH, or O_2C-R^{13}, wherein R^{13} is a C_1-C_{20} hydrocarbon group and at least one of R^1 to R^{12} is OH or O_2C-R^{13}; and

ii) a photoactive component.

26. The coated substrate of Claim 25, wherein the substrate comprises SiON.

27. The coated substrate of Claim 25, wherein the substrate comprises silicon.

28. A process for preparing a photoresist image on a substrate comprising, in order:

(A) applying a photoresist composition on a substrate, wherein the photoresist composition comprises:

(1.) the fluorine-containing copolymer of Claim 1;

(2.) a photoactive component; and

(3.) a solvent;

(B) drying the photoresist composition to substantialy remove the solvent to form a photoresist layer on the substrate;

(C) imagewise exposing the photoresist layer to form imaged and non-imaged areas; and

(D) developing the exposed photoresist layer having imaged and non-imaged areas to form a relief image on the substrate.